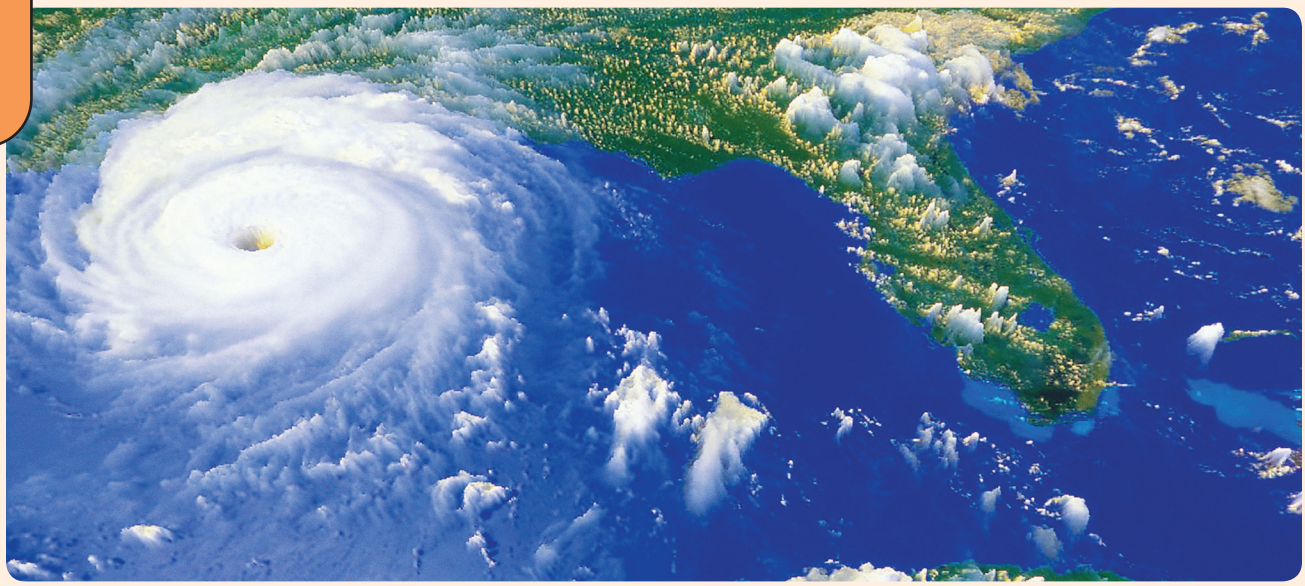
# Unit C Conclusion

Throughout this unit you have seen how Alberta's landscape and wealth of natural resources is the product of billions of years of change. As you travel through Alberta, you see hints of tectonic plates colliding and ice sheets advancing and retreating. Theories describing the processes that transform Earth change as new evidence comes to light. As new technology is developed, scientists are better able to observe changes in the past and present and then predict future changes. People now stand at a crossroads where they have become the agents of global change. You must evaluate your impact on Earth and then choose appropriate actions.



## Career Profile

### Petroleum Engineer

Rob Manuel is a petroleum engineer who has been working in the oil and gas industry since 1995. He has a Bachelor of Petroleum Engineering Degree from the University of Alberta.

Rob currently leads an exploration team assigned to identify gas pools, drill wells into these pools, and obtain gas from these pools. The gas is then sent to market with an aim to maximize profitability.

"With my position, every day truly offers a new and interesting challenge," he says. "I show up as a team player to work with a mutually supporting team. New challenges are welcomed, assessed, and resolved. What I learn from the resolution of each challenge keeps me motivated and wanting to learn more."

Having a scientific background has benefited Rob in every one of his jobs.

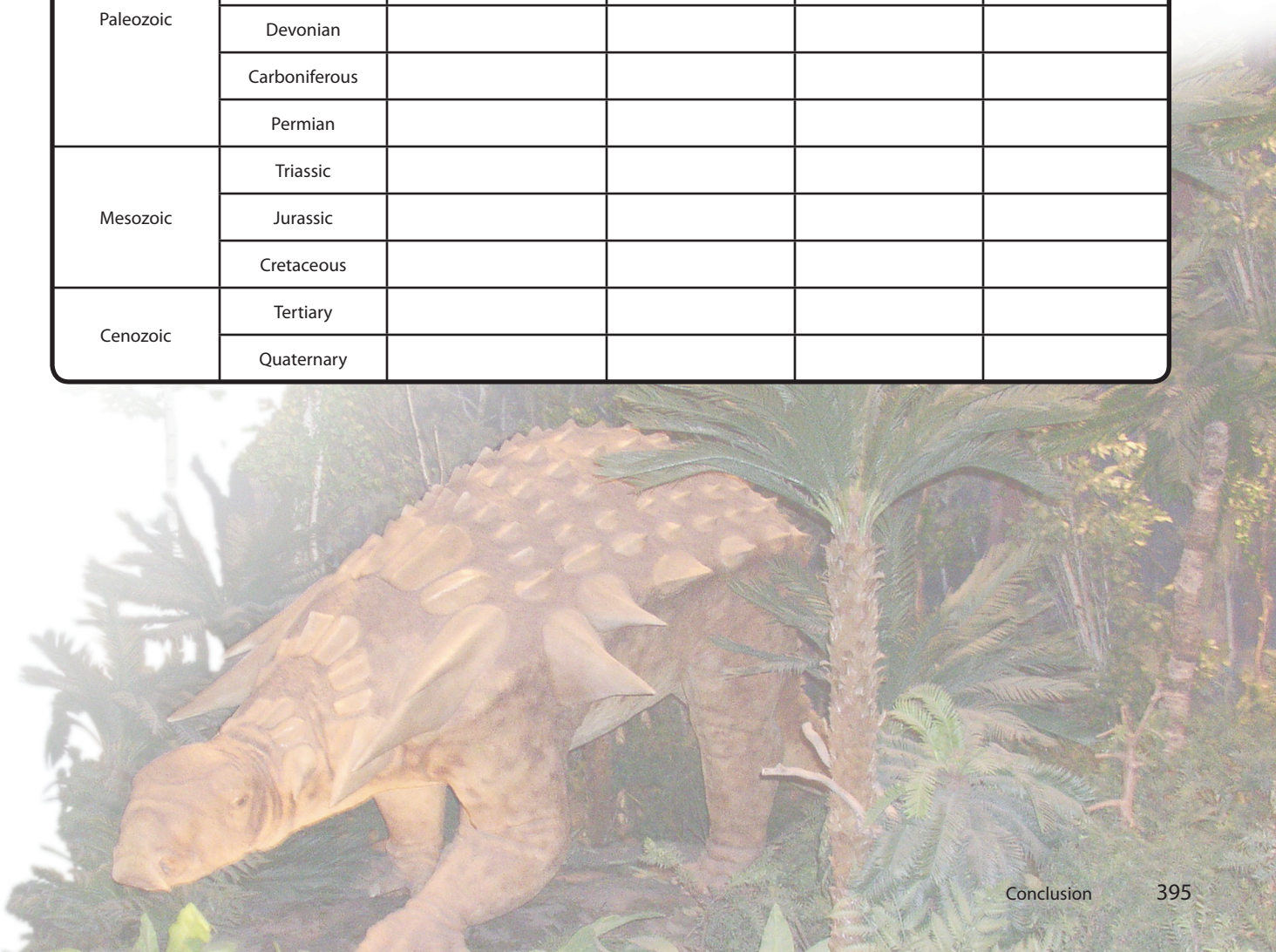
"The problem-solving techniques associated with being an engineer have allowed me to conquer and achieve all the goals I have set for myself," he says.

Immediately after graduation, he worked as an operations engineer in a sour gas processing plant. Rob's next assignment involved petroleum engineering responsibilities related to the development of heavy oil. And he also spent one year in supply chain management and two years managing Aboriginal Relations.

# Unit C Review Questions

**1.** Now would be a good time to review the story of Alberta. Watch the applet "Geomorphology," on the Science 20 Textbook CD. Copy the following table row by row, so that you will have enough space. As you view the applet, fill in the table. Remember, you can pause and rewind as much as you wish. The first row is done for you. Note that the Tertiary Period is basically skipped in the applet—you will have to provide the information for this one on your own.

| Era | Period | Time Frame (Millions of Years Before Present) | Environmental Conditions | Events and Life Forms | Societal Connection (Fossil Fuels) |
|---|---|---|---|---|---|
| Precambrian | | 4500 to 590 | volcanic, hot | • life begins in sea<br>• algae, bacteria, primitive worms | none |
| Paleozoic | Cambrian | | | | |
| | Ordovician/ Silurian | | | | |
| | Devonian | | | | |
| | Carboniferous | | | | |
| | Permian | | | | |
| Mesozoic | Triassic | | | | |
| | Jurassic | | | | |
| | Cretaceous | | | | |
| Cenozoic | Tertiary | | | | |
| | Quaternary | | | | |



**2.** The following table summarizes the important concepts of Unit C. Copy this table into your notebook. Go row by row, so you end up with enough room. The first entry is done for you.

| Concept | Explanation | Examples | Connection to Technology and/or Society |
|---|---|---|---|
| challenges of investigating changes to Earth's crustal plates | Earth's history has occurred over billions of years and is recorded all across the planet in sedimentary rocks thousands of metres thick. | • most rocks and fossils from early in Earth's history destroyed by rock cycle | • new technological advances—ground-penetrating radar, GPS satellites, radiometric-dating techniques—help scientists overcome challenges |
| evolution of geological process theories | | | |
| energy released by earthquakes | | | |
| layers for Earth's internal structure | | | |
| plate tectonics | | | |
| driving force for plate tectonics | | | |
| determining absolute age | | | |
| fossilization | | | |
| determining relative age | | | |
| evidence of past climates in rocks | | | |
| life forms affect atmosphere's composition | | | |
| evidence of repeated glaciations in Alberta | | | |
| ice cores show evidence of warming, cooling | | | |
| several theories about causes of climate change exist | | | |

Use Figure C3.40 and the paragraph that follows to help you answer questions 3 to 15.

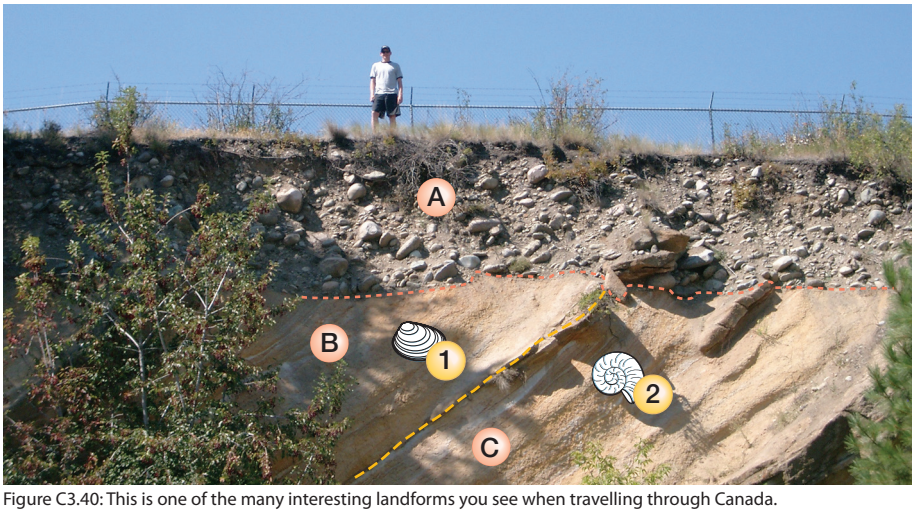


Figure C3.40: This is one of the many interesting landforms you see when travelling through Canada.

When travelling through Alberta and the rest of the country, you might see interesting landforms that make you wonder how they formed or what information they hold. Suppose that during a summer road trip to Vancouver, you stopped for lunch at a diner in Princeton, B.C. Right beside the parking lot was a stunning outcropping that made you think of a James Hutton painting. You began to wonder about the story recorded in these rocks.

Although you were unable to truly investigate this outcropping, questions 3 to 16 explore some possibilities and will help you review key concepts from Unit C. Note that the fossils in Figure C3.40 are not drawn to scale.

**3.** Identify which important theory James Hutton is credited with originating.

**4.** Explain Hutton's theory.

**5.** List layers A, B, and C in Figure C3.40 in order from oldest to youngest.

**6.** Infer the scientific law you had to apply to answer question 5.

**7.** Suggest how this rock formation formed.

**8.** Which fossil is younger—fossil 1 or fossil 2?

**9.** Fossil 1 is called *Vernericardia*. It's an index fossil from the Tertiary Period. Which era is the Tertiary Period part of?

**10.** Fossil 2 is an ammonite from the Cretaceous Period. Using the information provided in Unit C, determine the range of possible ages for layer C.

**11.** Explain what may have occurred at the boundary between layers A and B.

**12.** If layer C contains 93% uranium-235 and 7% lead-207, what is its age?

**13.** Is the date you determined in question 12 relative or absolute?

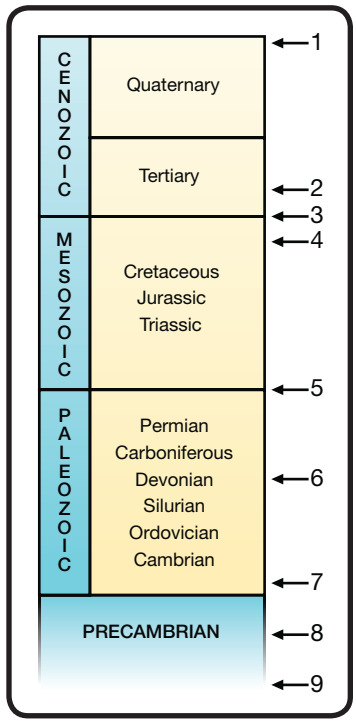
**14.** Describe how layer A shows evidence of glaciation.

**15.** When was layer A likely deposited?

**16.** Match each of the following events to the correct number on the table titled "The Geological Column." The column is not drawn to scale.

**a.** Burgess Shale
**b.** extinction of dinosaurs
**c.** greatest mass extinction
**d.** last ice age
**e.** break-up of Pangaea
**f.** age of fishes
**g.** first appearance of life
**h.** when mammals first became abundant
**i.** oldest rocks on Earth

The Geological Column




Use the information in Figure C3.41 to answer multiple-choice questions 17 to 19.

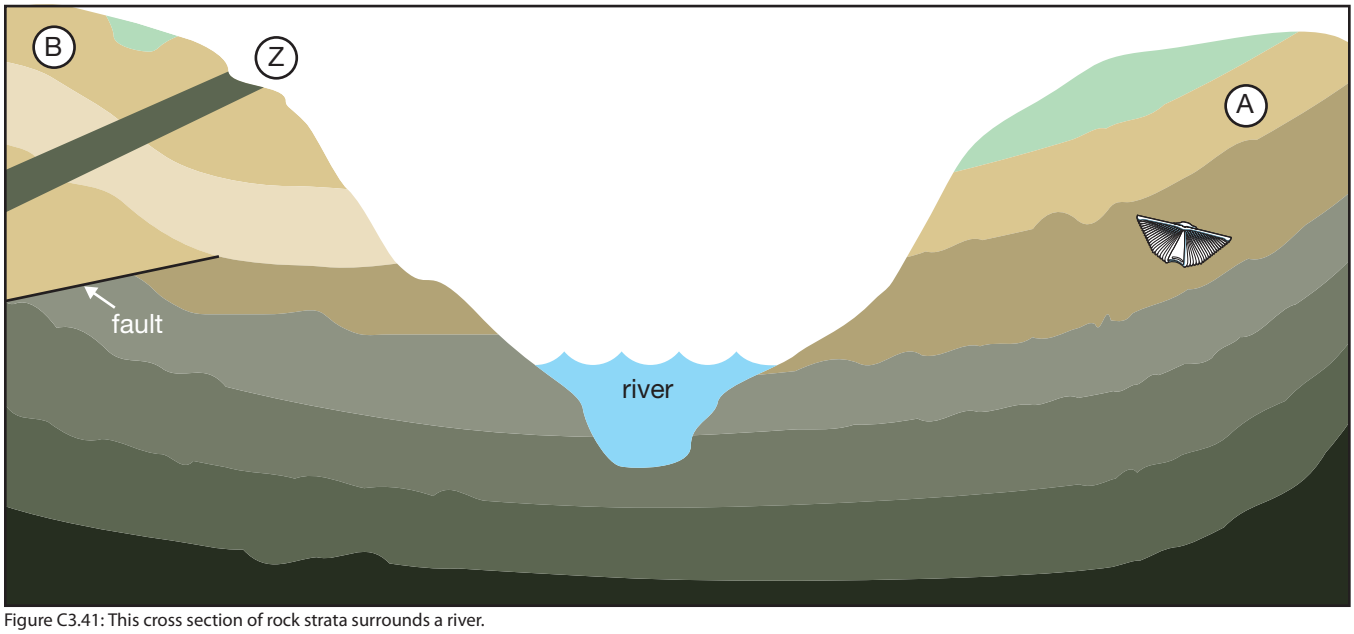



Figure C3.41: This cross section of rock strata surrounds a river.

**17.** The fossil on the right-hand side of the cross section is from the Devonian Period. Which of the following is a possible period for layer A?

**A.** Precambrian
**B.** Cambrian
**C.** Silurian
**D.** Permian

**18.** The igneous rock unit labelled Z has been radioisotope-dated at 62 million years. The range of ages for B is most likely to be

**A.** 65 million to 225 million years old
**B.** younger than 62 million years old
**C.** between 62 million and 65 million years old
**D.** the same age as formation A

**19.** The igneous rock unit labelled Z is called

**A.** an intrusion
**B.** a ridge
**C.** a subduction zone
**D.** a plate boundary

**20.** Describe a circumstance that would increase the chances of an animal's remains fossilizing.

Use the information from this paragraph and Figure C3.42 to answer questions 21 to 23. Scientists discovered two cliffs on different continents that were separated by an ocean. From the geological record, the scientists concluded the continents were—at one time—joined together and then separated. The geological evidence is shown in the geological columns in Figure C3.42.

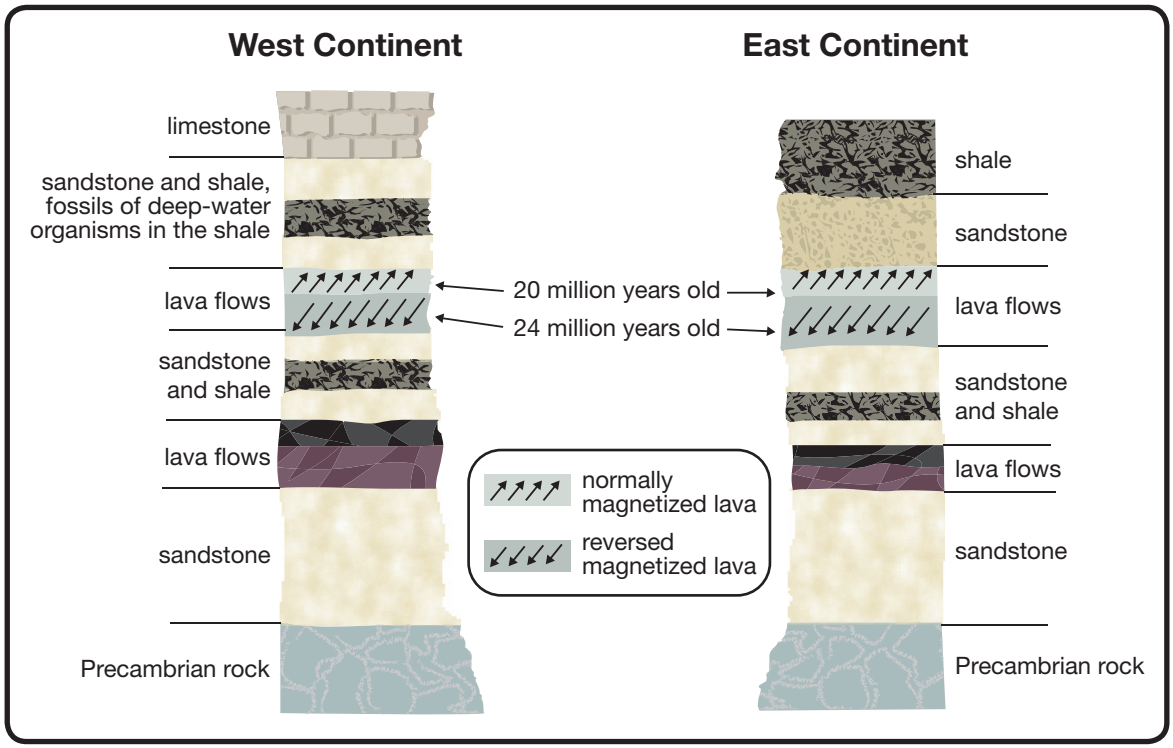



Figure C3.42: Rock strata on two continents are separated by an ocean.

**21.** Describe two different types of evidence that indicate that the two continents were once joined.

**22.** The 24-million-year-old lava flows are thicker than the 20 million-year-old lava flows. What could be responsible?

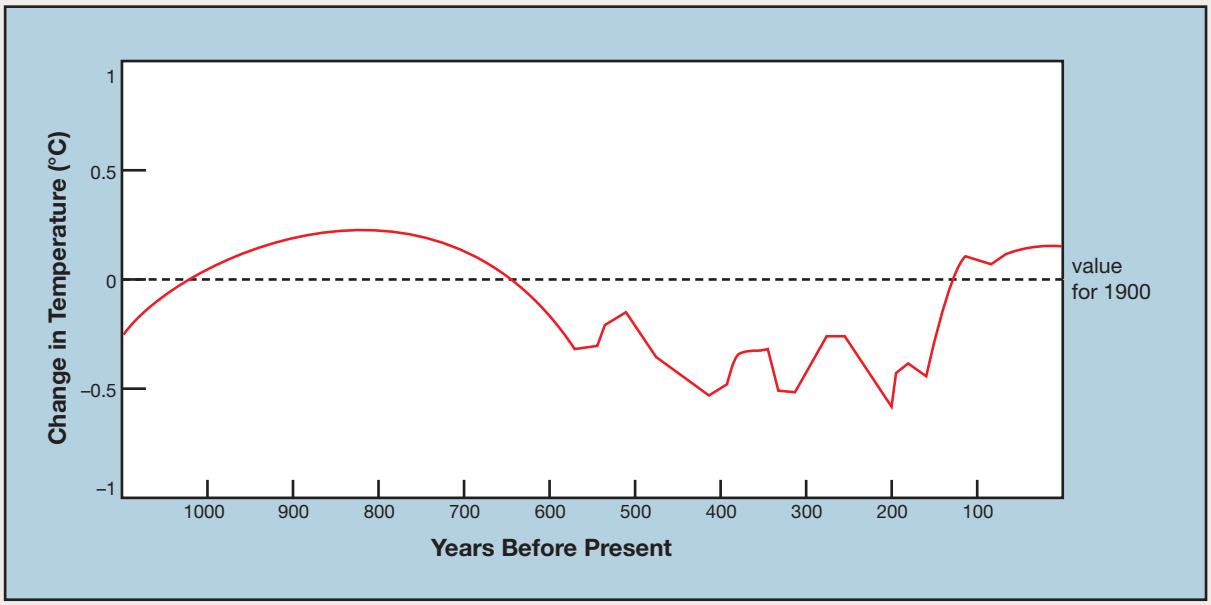
**23.** The age of the continental separation was dated to be approximately 20 million years ago. Describe the evidence in the geological columns that supports this date.

Use “Changes in Earth’s Surface Temperature Versus Time” to answer question 24.

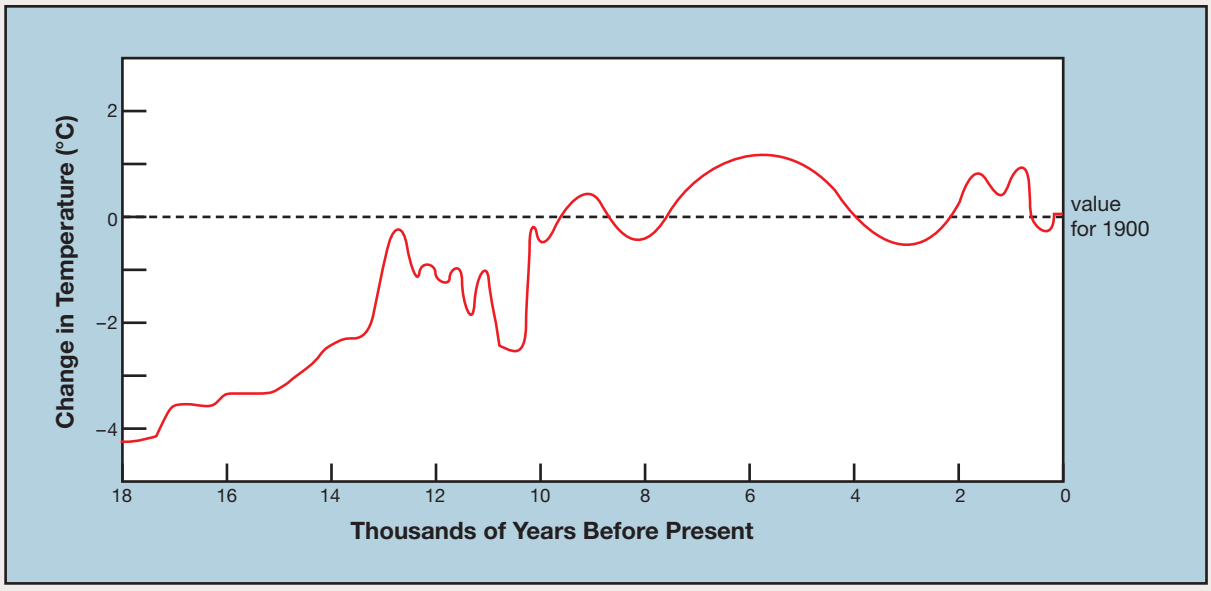
## Changes in Earth’s Surface Temperature Versus Time

The following graphs indicate how the mean temperature for Earth’s surface changes over time. For all four graphs, in order from short term to very long term, the change in the mean temperature of Earth’s surface is referenced to the value from 1900 as the base value. In other words, the temperatures for the different time periods have been compared to the 1900 value. The graphs differ in the time scale displayed on the horizontal axis. Note that the different time scales required different data-collecting techniques. This has led to some inconsistencies, but the overall data trends are essentially the same.

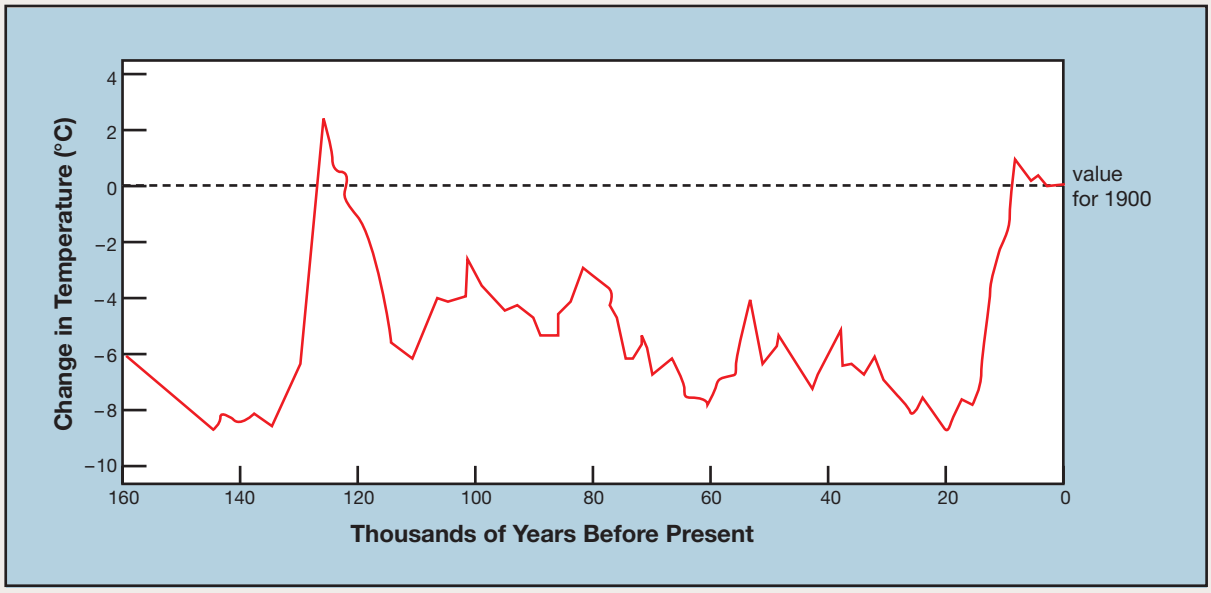
Graph I



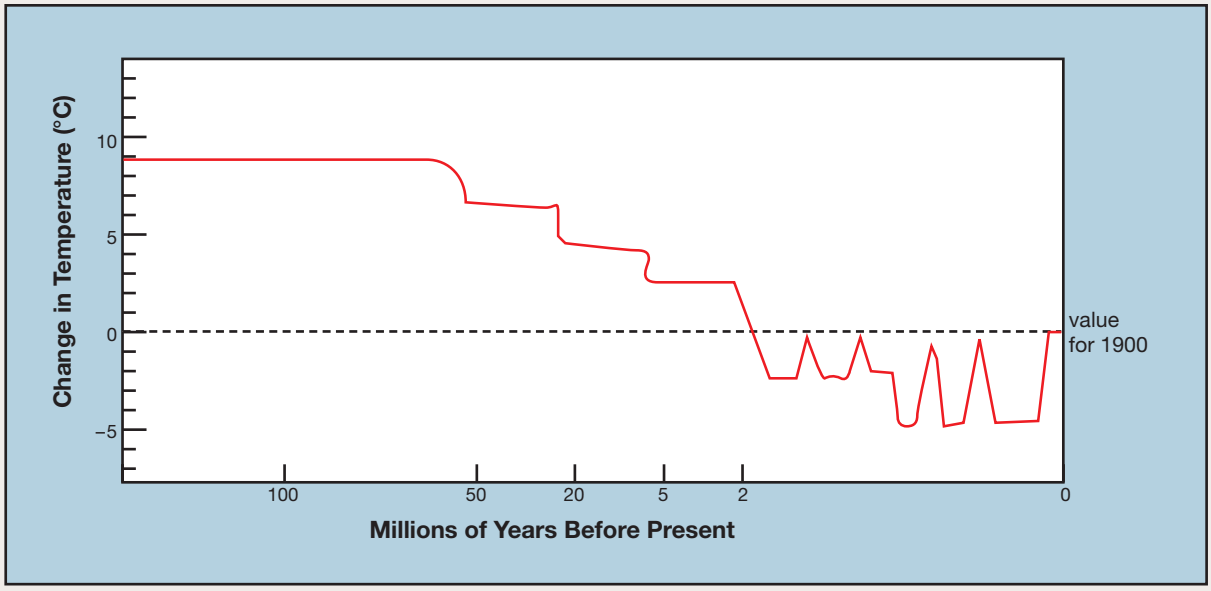

Graph II



Graph III




Graph IV




**24.** Each graph provides information about the change in average temperature at Earth's surface relative to the temperature value for 1900. The major differences between the graphs are the time scales presented on the horizontal axes for the graphs. Choose which graph could best be used to help investigate each of the following research topics.

**a.** An analysis of ice-core data from Greenland indicates that a sudden global cooling event triggered climatic changes in northern Europe about 8200 years ago. Archaeological research suggests that the human population living in these places experienced a significant drop in numbers during the 200 years of sudden cooling. Once temperatures returned to pre-cooling values, new people moved into these areas from Asia and the Middle East. It is thought that these people brought an advanced culture of settled villages to northern Europe that made use of domesticated plants and animals.

**b.** Geological evidence suggests that 70 000 years ago, a violent volcanic eruption occurred on Mount Toba on the present-day Indonesian island of Sumatra. Evidence suggests so much material was spewed into the atmosphere that Earth was plunged into a six-year volcanic winter and a 1000-year instant ice age. Archaeological evidence from Blombos Cave in South Africa reveals that humans at this time had developed tools for fishing, and they also carved abstract symbols on cave walls. Some archaeologists have theorized that the harsh climate may have forced these early humans to be more creative in order to survive.

**c.** The Ancestral Pueblo or Anasazi were people who lived in the canyons of the American Southwest. These people built multi-room, masonry dwellings known as pueblos, which is Spanish for "village." These people developed elaborate water catchments for the corn crops that were the staple food of their agricultural society. A global warming period that began about 1000 years ago may have caused a prolonged, severe drought in this area. A lack of rainfall may have been the key event that triggered the decline of both the society and culture of the Ancestral Pueblo people. By the year 1300, their elaborate masonry homes had been abandoned.

**25.** Refer to the information presented in question 24. Choose one of the three research topics presented and perform an Internet search to investigate the connections among climate, human activity, and culture suggested by each topic.

**26.** Use the following standard to complete a self-evaluation of your time line.

| Score | Scoring Description |
|---|---|
| Standard of Excellence (4 marks) | The response is well organized and accurately describes the events in Alberta's history. The description of events reflects a clear and thorough understanding and consistent logical thought. The descriptions are accompanied by a suitable organizer, such as the time-scale handout or a logical and/or creative organizer designed by the student. |
| Acceptable Standard (2 marks) | The response addresses most major events. The descriptions may be inconsistent in the employment of appropriate scientific vocabulary, and the graphic organizer may be poorly used. The descriptions may be disorganized, but they demonstrate a correct understanding. |

Figure C3.43: Pueblos were built by the Ancestral Pueblo or Anasazi people.